# Abstracts

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**Tree species of excavated charcoal from Kurokawa-Nishiyama site,** S. HAYASHI: Examination Report of Kurokawa-Nishiyama Site, Chap. V, Natural Scientific Analysis 1, 15-22, Toyama Pref., Kosugi-Machi Educational Committee (1989) (in Japanese)

Tree species of charcoals (227 specimens) excavated from 5 kilns (Nara era) were identified. *Abies firma* (9) was an only coniferous species and as to broard leaved species, *Castanea crenata* (74), *Prunus* sp. (41), *Morus bombycis* (17), *Cornus* sp. (13), *Alnus japonica* (10) and *Magnolia* sp. (10) were main species, and other 15 miscellaneous species were identified. It is thought that all these species had been growing near the kilns.

**Tree species of excavated charcoals from Ettyu Uwazue Kilns,** S. HAYASHI: Report upon Archaeological Research in the Toyama University, Vol. 3, Ettyu Uwazue Kilns, A Report of the Excavation of Ancient Sue Pottery (Unglazed Pottery) Kilns in Toyama, Japan, Chap. 6 Natural Scientific Analysis 4, 209-214, Toyama University (1989) (in Japanese)

Tree species of charcoals (44 specimens) excavated from 5 kilns (8th to 10th century) were identified. The identified species are specialized by kilns and eras. It was considered that these species had been growing around the klin. *Cryptomeria japonica* (9) (Kiln No. 1) and *Castanea crenata* (9) (Kiln No. 3) were dominant identified species.

**Development of CAI Courseware for Wood Histology (II) ……Chapter of Soft Wood……,** Y. IZUMOTO, S. HAYASHI, K. KAWANISHI, Y. NISHIMORI and D. TANAKA: Memoirs of Osaka Kyouiku University, Ser. V, School Subjects and Allied Problems, Vol. 38, No. 2, 275-284 (1989) (in Japanese)

By using the shell reported in our 1st paper, we developed CAI courseware for wood histology for the persons who participate in wood technology, and who have interest in wood identification. The contents of this courseware are mainly on softwood characters for identification of species. The feature of this courseware is easy for users to comprehend wood histology, by displaying many anatomical photomicrographs and explanation. This courseware is comprised of 6 sections, that is, Appearance of wood, Tracheid, Axial parenchyma, Ray, Pit, and Resin canal. The frames of this courseware are 31 in all, and this courseware is comprised of 35 photomicrograph data, 4 schematic diagram data and 39 text data.

**Wood species of the horse-equipment.** K. SHIMAJI and S. HAYASHI: Ikaruga

Fujinoki Kofun (Tomb Mound), Report of the First Examination, Part III Wood, 276-289, Kashihara Koukogaku Kenkyusho (Archaeological Institute) (1990) (in Japanese)

Wooden relics (15 specimens) from horse-equipments were examined microscopically. The tree species identified were as follows: Maewa-kurakanagu (Saddlebow); *Carpinus* sp. and *Pinus* (Diploxylon) sp., Kurahashi (Saddle body); *Carpinus* sp., Hoyoutsuki-Shirigai-Kazarikanagu (Crupper ornament); *Quercus* sp. (Cork), and Abumi (Stirrups); *Rhus chinensis*. Presumption on the manufacturing locality of this horse-equipment, was unsuccessful on the basis of above result alone.

**Biogenesis of cellulose microfibrils and the role of microtubules in green algae,** T. ITOH: In "Plant cell wall polymers-Biogenesis and biodegradation", N. G. LEWIS and M G. PAICE, Ed., ACS Symposium Series No. 399, 257-277 (1989)

This chapter reviews our knowledge of factors controlling cellulose deposition in green algae. Firstly, the types of cellulose synthesizing particle complexes in green algae are discussed. Secondly, new evidence on the orientation of microtubules in selected giant marine algae and their relationship to the orientation of cellulose microfibrils is presented. Based on this information, a mechanism for the assembly of cellulose microfibrils in giant marine algae is proposed.

**Lignification of bamboo (*Phyllostachys heterocycla* Mitf.) during its growth,** T. ITOH: Holzforsch. **44** (3) 191-200 (1990)

Transverse and longitudinal progresses of lignification in the culm of *Phyllostachys heterocycla* was investigated from the stage of the sprout to the full grown culm within one growing season, combined with the observation of external morphology of the culm. Lignification was also investigated by chemical analysis in the 2, 3, 6, 8, 10, 12, and 14 years-old culms. The results obtained are as follows: (1) Lignification within one internode proceeds downward from upper to lower side, (2) transverse progress of lignification proceeds inward from outside to inside of the culm, (3) axial progress of lignification in the component cells of epidermal cells, fibers and parenchyma cells proceeds upward from the basal internode to the top one, (4) lignification of epidermal cells and fibers precedes that of ground tissue parenchyma and sclerotic parenchyma cells, (5) lignification of fibers initiates at the basal internode early in the elongation of the culm and occur in all internodes as the full elongation of culm; however, the lignification of parenchyma cells does not occur in the upper internodes at the full elongation of the culm, (6) the massive lignification of the parenchyma cells occur after the growth of new lateral shoots and leaf flush, and reaches to its highest level after the full opening of new

leaves, (7) full lignification of the component cells completes within one growing season. Any further progress of lignification in any kind of component cells is not suggested to occur in the aged culm.

**Cellulose synthesizing complexes in some giant marine algae**, T. ITOH: J. Cell Sci. **95**, 309-319 (1990)

The structure of putative cellulose synthesizing complexes (TCs) has been studied in giant marine algae and is discussed in relation to the assembly of cellulose microfibrils. Including previous work, 14 species belonging to nine genera in the Siphonocladales and two species in the Cladophorales are known to have linear TCs on both E-and P-fracture faces of the plasma membrane. Species studied in the present paper included *Boodlea composita, Dictyosphaeria cavernosa, Ernodesmis verticillata, Siphonocladus tropicus, Struvea elegans, Valoniopsis pachynema* and *Chaetomorpha aerea* Contrary to their fairly consistent width (30~36 nm), TCs have a wide distribution of length among individual species and at various stages of development in the same species. Most of the TCs have a random arrangement of subunits, but sometimes they are arranged in three rows. The mean TC length is greater during secondary wall synthesis than in primary wall synthesis in all of the following species: *Boodlea composita, Dictyosphaeria cavernosa, Siphonocladus tropicus, Valonia macrophysa Valonia ventricosa* and *Chaetomorpha aerea*. These results support previous results suggesting that the linear TCs increase their length during cell wall development. The size of TC subunits, ranging from 7.3 to 8.9 nm, was smaller than the structural membrane particles on the plasma membrane in all of the species examined. It is suggested that the spacing between individual glucan chains will be reduced to half after crystallization of cellulose microfibrils, on the basis of evidence that the width of microfibrils is as wide as that of TC. The width of micro fibrils ranged from 11.2 to 23.6 nm, while most of the species had microfibrils with a width in the range 14 to 16 nm. The width of microfibrils in *Boergesenia* was the largest among the giant marine algae. The formation of TCs from subunits, which are transmembrane particles, is characteristic of Siphonocladales in spite of their varying cell morphology.

**Identification of wood excavated from Souma district under development**, T. ITOH: In, "Souma-Kaihatsu-Kanren Iseki Chousa Houkoku II", Fukushimaken Bunkazai Chousa-Houkokusho No. 234, Educational and Cultural Committee of Fukushima Prefecture, and Cultural Center of Fukushima Prefecture, 605-738 (1990)

The wood and wooden articles of 780 specimens excavated from Souma district including Futago, Moroyama, Oomori-A, Minamikawajiri-B, Washizuka, Karasaki.

Furukawajiri-B, Imagami relics for last three years from 1987 to 1989 were identfied as follows: *Torreya nucifera* S. et Z., *Abies firma* S. et Z., *Pinus* sp. (Diploxylon), *Cryptomeria japonica* D. Don, *Chamaecyparis obtusa* Endle, *Alnus* sp., *Ostrya japonica* Sarg., *Fagus crenata* Blume, *Quercus* sp. (Lepidobalanus sect. Cerris London), *Quercus* sp. (Lepidobalanus, sect. Prinus London), *Castanea crenata* S. et J., *Zelkova serrata* Makino, *Magnolia ovobata* Thunb., *Euptelea polyandra* S. et Z., *Cercidiphyllum japonicum* S. et Z., *Camellia japonica* L., *Sorbus alnifolia* C. Koch, *Prunus* sp., *Orixa japonica* Thunb., *Phellodendron amurense* Rupreht, *Rhus trichocarpa* Miquel, *Acer* sp., *Ilex integra* Thunb., *Elaeagnus* sp., *Evodiopanax innovans* Nakai, *Styrax japonica* S. et Z., *Fraxinus japonica* Blume, *Callicarpa japonica* Thunb., *Populus* sp., *Betula* sp.

**Structure and properties of the lignin-carbohydrate complex polymer as an amphipathic substance**, T. KOSHIJIMA, T. WATANABE and F. YAKU: ACS Symposium Series No. 397, 11 (1989)

It has been found that lignin-carbohydrate complexes (LCCs) consist of sugar chains and relatively small lignin fragments attached as pendant side chains; they have number-average molecular weights of ca. 6000–8000. The linkage between sugar and lignin was determined to be mainly of the benzyl ether type by a newly developed method using DDQ oxidation. Some of the LCCs exhibit a strong tendency to form micelles or aggregates in aquenous solution due to hydrophobic and also electrostatic interactions.

**The structures of nitrogen containing derivatives prepared from dialdehyde celluloses**, E. MAEKAWA and T. KOSHIJIMA: in "Cellulose, structural and functional aspects" (Eds., J.F. Kennedy, G O. Phillips, and P.A. Williams), Ellis Horwood Ltd., New York, 337–344 (1989)

Various nitrogen-containing derivatives from dialdehyde celluloses were prepared under different pH conditions. On the basis of the results from analytical data and IR absorption spectra of the products, the structures and characteristics of nitrogen-containing products obtained from dialdehyde celluloses are discussed and also evaluated with respect to the hemialdal seven-membered cyclic structure proposed by Barry et al. before.

**An evaluation of the acid soluble lignin determination in analyses of lignin by the sulfuric acid method**, E. MAEKAWA, T. ICHIZAWA and T. KOSHIJIMA: J. Wood Chem. Technol., **9**(4), 549–567 (1989)

The acid-soluble lignin determination used analyses of lignin by the sulfuric acid method was evaluated. The conventional UV spectrophotometric method using the absorption at 205 nm is appropriate for hardwoods, whereas for softwoods and bam-

boo the absorption at 205 nm should be corrected, since the absorption maximum is shifted to a shorter wavelength in sulfuric acid solution. Therefore, in the latter cases, the actual absorption maximum should be used.

**Preparation and characterization of hydroxamic acid derivative and its metal complexes derived from cellulose,** E. MAEKAWA and T. KOSHIJIMA: J. Appl. Polymer Sci., **40**, 1601-1613 (1990)

Cellulose-hydroxamic acid derivatives, which were reported as a novel cellulose derivative, were prepared from dialdehyde cellulose obtained by periodate oxidation of cellulose, and certain properties of unusual cellulose derivative containing hydroxamic acid groups and of various metal complexes formed with heavy metal ions were characterized in this investigation.

**Modeling in Crystal Structure Analysis of Polysaccharides,** A. SARKO, C.-H. CHEN, B. J. HARDY and F. TANAKA: A. D. French and J. W. Brady ed., Computer Modeling of Carbohydrate Molecules, ACS Symposium Series, No. 430, Chapter 21, 345-360 (1990)

The utility of modeling in diffraction analysis of polysaccharides is demonstrated by a 20-year accumulated record of successful structure determinations. However, as the results obtained with some polysaccharides—notably celluloses—have shown, some structural details can remain unresolved. The ambiguities may be traced to varying modeling methods, particularly when applied to differing data sets. When structurally different but superficially similar models are possible, different methods may produce results that are inconsistent, not allowing the identification of the most probable structure. Nonetheless, modeling methods are steadily extending the capabilities of structure analysis of polysaccharides, both in crystalline and other states. Especially, simulations of molecular dynamics may offer the most promise in dealing with the amorphous and gel states, as well as with crystalline phase transformations. Of the latter, mercerization of cellulose is of particular interest.

**Aromatic ring cleavage of vanillyl alcohol by lignin peroxidase of *Phanerochaete chrysosporium*,** T. HATTORI, M. SHIMADA and T. HIGUCHI: Mokuzai Gakkaishi, **35**, 933-937 (1989)

The cleavage of the phenolic aromatic ring, catalyzed by the lignin peroxidase of a basidiomycete *Phanerochaete chrysosporium* Burds., was studied by use of vanillyl alcohol as a model substrate. The main product obtained was dehydrodivanillyl alcohol formed by a C-C coupling. However, a phenolic ring cleavage product, δ-lactone, was identified by comparison of its mass spectrum with that of an authen-

tic compound. The result showed that the lignin peroxidase catalyzes cleavages of not only non-phenolic aromatic rings as previously reported but also phenolic aromatic rings. Thus, it is conceivable that the phenolic ring cleavage-reaction also occurs in the degradation of lignin polymer by white-rot fungi under natural conditions since protolignin seems to be degraded without undergoing so many couplings of phenolic units as previously expected.

**Degradation of synthetic lignin, a dehydrogenation polymer, by lignin peroxidase in the presence of veratryl alcohol,** T. UMEZAWA and T. HIGUCHI: Mokuzai Gakkaishi, **35**, 1014–1020 (1989)

Degradation of synthetic lignin, a dehydrogenation polymer (DHP), by lignin peroxidase of a white-rot basidiomycete (*Phanerochaete chrysosporium* Burds.) was investigated. The enzyme catalyzed aromatic ring cleavage, β-O-4 bond cleavage and $C_\alpha$-$C_\beta$ cleavage of a DHP prepared from coniferyl alcohol and arylglycerol-β-syringaresinol ether only in the presence of veratryl alcohol. A β-O-4 lignin substructure model dimar, however, was degraded efficiently by the enzyme without veratryl alcohol, although veratryl alcohol accelerated its degradation.

**Degradation of phenolic β-1 lignin substructure model dimer by *Phanerochaete chrysosporium* and its lignin peroxidase,** S. YOKOTA, T. UMEZAWA, T. HIGUCHI, S. KAWAI: Holzforschung, **44**, 271 (1990)

A phenolic β-1 lignin substructure model dimer, 1-(3,5-dimethoxy-4-hydroxyphenyl)-2-(3,5-dimethoxy-4-ethoxyphenyl)propane-1,3-diol (I) was degraded by both intact cells of *Phanerochaete chrysosporium* and its lignin peroxidase. In the degradation of substrate (I) by the fungus, the following compounds were formed: 2,6-dimethoxy-*p*-hydroquinone (II), syringaldehyde (III), 1-(3,5-dimethoxy-4-ethoxyphenyl)-ethane-1,2-diol (IV), 2-(3,5-dimethoxy-4-ethoxyphenyl)propane-1,3-diol (V), and 1-(3,5-dimethoxy-4-hydroxyphenyl)-2-(3,5-dimethoxy-4-ethoxyphenyl)-3-hydroxypropanone (VIII). While by the enzyme substrate I was degraded to the following five compounds: II, III, IV, 2-(3,5-dimethoxy-4-ethoxyphenyl)-3-hydroxypropanal (VII), and 1-(3,5-dimethoxy-4-hydroxyphenyl)-2-(3,5-dimethoxy-4-ethoxyphenyl)-2-propene-1-one (IX). The results showed that substrate I was degraded via three types of reactions, alkyl-aryl cleavage, Cα-Cβ cleavage, and Cα oxidation by both the intact cells of the fungus and lignin peroxidase.

**A new biomimetic lignin degradation system developed with Mn/Co catalysts and its application to the chlorine free bleaching of kraft pulp,** M. SHIMADA, M. NAKAGAWA, T. HATTORI and T. HIGUCHI: Mokuzai Gakkaishi **35**, 859–860 (1989)

A new biomimetic catalytic system with Mn/Co has been developed in order to degrade lignin model compounds and bleach unbleached kraft pulp. Non-phenolic lignin model β-O-4 model dimer underwent $C_\alpha$-$C_\beta$ bond cleavage as well as the β-O-4 ether bond cleavage in the presence of manganese acetate complex and peracetic acid. The new biomimetic bleaching method demonstrated that unbleached hardwood kraft pulp is bleached to about 80% from 35% brightness, whereas the control system without Mn catalyst yielded 53% brightness.

**Production of secondary metabolites including a new metabolite *p*-methoxyphenylpropanol by the brown-rot fungus *Lentinus lepideus*,** A. OHTA, M. SHIMADA, T. HATTORI, T. HIGUCHI and M. TAKAHASHI: Mokuzai Gakkaishi, **36**, 225-231 (1990)

The secondary metabolites, which were biosynthesized from glucose by the brown-rot fungus *Lentinus lepideus* Fries grown in cultures with varying amounts of nitrogen nutrients, were determined. The low nitrogen concentration culture produced much greater amounts of the metabolites per nitrogen gram unit than did the high nitrogen concentration culture. A new secondary metabolite, *p*-methoxyphenylpropanol, was isolated from the cultures of this fungus. Incubation of the cultures with compounds, such as *p*-coumaric acid, *p*-methoxycinnamic acid, ferulic acid, iso-ferulic acid, and methyl ferulate, yielded a variety of phenylpropanol derivatives. A possible biosynthetic route to form *p*-methoxyphenylpropanol also is discussed. Among 75 species of secondary metabolites, only the brown-rot fungus *Daedalea dickinsii* Yasuda produced methyl *p*-methoxycinnamate.

**Effects of carbon and nitrogen nutrients on production of secondary metabolites by a brown-rot fungus *Lentinus lepideus*,** A. OHTA, M. SHIMADA, T. HIGUCHI and M. TAKAHASHI: Mokuzai Gakkaishi, **36**, 565-572 (1990)

Variations in the amounts of secondary metabolites of the brown-rot fungus, *Lentinus lepideus* Fries, grown in four different cultures with high (H) or low (L) levels of carbon (C) and nitrogen (N) concentrations were investigated. Nitrogen-limited (HC/LN) culture which was used as a wood-decay model system showed the two maximal peaks of the metabolites during a cultivation period of 63 days; the first peak, which consisted chiefly of methyl *p*-methoxycinnamate and methyl *p*-methoxybenzoate, appeared on Day 11 after almost complete depletion of nitrogen, which occurred on Day 6, and the second one, which consisted of only methyl *p*-methoxycinnamate, appeared on Day 33 at the time of about 60% consumption of glucose in the culture. The culture medium of high carbon and high nitrogen (HC/HN) levels produced the metabolities in the greatest amounts among the media used. However, on the basis of the gram unit of N used, the amounts of

the metabolites and mycelial weight of the fungus in HC/LC culture were much greater than those in HC/HN culture. The addition of L-glutamate or ammonium ion to the HC/LN culture did not suppress the synthesis of the metabolites. The total amounts of the secondary metabolites were proportional to the mycelial weights of the fungus in both HC/HN and HC/LN cultures. A possible significance of the biosynthesis of L-phenylalanine-derived metabolites is discussed in relation to the recycling of the ammonium nitrogen of the aromatic amino-acid under nitrogen-starved conditions.

**A novel enzymatic decarboxylation of oxalic acid by lignin peroxidase system of white-rot fungus *Phanerochaete chrysosporium*,** Y. AKAMATSU, D.B. Ma, T. HIGUCHI and M. SHIMADA: FEBS Lett., **269**, 261–263 (1990)

Oxidation of veratryl alcohol by lignin peroxidase (LiP) was potently inhibited by oxalic acid. The inhibition analysis with Lineweaver-Burk plots clearly showed that the type of inhibition is non-competitive. The enzymatic oxidation of veratryl alcohol in the presence of $^{14}C$-oxalic acid yielded radioactive carbon dioxide. The results indicate that the apparent inhibition of LiP is caused by reduction of the veratryl alcohol cation radical intermediate back to the substrate level by oxalate, which is concomitantly oxidized to carbon dioxide.

**Lignin Peroxidase and its Mimetics:** M. Shimada: Kagaku (Chemistry), **45**, 454–455 (1990) (in Japanese)

Recent advances in lignin degradation with enzymes and its mimetic catalysis are comprehensively introduced to readers in other disciplines.

**Degradation mechanism of lignin accompanying steam explosion. II. High pressure steam tretment of guaiacylglycerol-β-guaiacyl ether and white birch wood.** M. TANAHASHI, M. KARINA and T. HIGUCHI: Mokuzai Gakkaishi, **36**, 380–388 (1990)

A lignin substructure model compound, guaiacylglycerol-β-guaiacyl ether was treated with high pressure steam (at 28 kg/cm$^2$, 230 °C for 4 min). The degradation products obtained were identified and compared with those by steam explosion to characterize the degradation mechanism of lignin by steam explosion. The degradation products of guaiacylglycerol-β-guaiacyl ether by steam treatment were almost the same as those from steam explosion. Coniferyl alcohol and guaiacol were major products, and followed by vanillin, vanillyl alcohol, coniferyl aldehyde, *d,l*-pinoresinol, *d,l*-epipinoresinol, and dehydrodiconiferyl alcohol. The formation of pinoresinol and phenylcoumaran from guaiacylglycerol-β-guaiacyl ether was consistent with the homolytic cleavage of Cβ-O ether linkage to produce coniferyl alcohol

radical and guaiacol radical followed by their coupling to derive the dimers. The formation of coniferyl alcohol and coniferyl aldehyde suggested that disproportionation of coniferyl alcohol radical occurred. Furthermore one electron reduction of the radical led to a higher yield of coniferyl alcohol than coniferyl aldehyde.

It is concluded that a homolytic cleavage reaction occurred as main degradation reaction of lignin in wood by steam treatment and steam explosion.

**Effect of hydrophobic regions of hemicelluloses on dehydrogenative polymerization of sinapyl alcohol,** M. TANAHASHI and T. HIGUCHI: Mokuzai Gakkaishi, **36**, 424-428 (1990)

In this paper the dehydrogenative polymerization of sinapyl-alcohol in the presence of hemicelluloses was studied by the membrane method. Sinapyl alcohol LCC formed was mainly composed of $\beta$-aryl ether linkage and the content of syringaresinol was remarkably low. The result suggested that 1) the reaction in aq. solution of hemicelluloses proceeded as did in dioxane and 2) dehydrogenation of the alcohol in the presence of hemicelluloses in water was favorite to the formation of $\beta$-aryl ether linkage to lead high polymers.

It is therefore concluded that dehydrogenative polymerization of monolignols in plant cell walls could occur in hydrophobic region of hemicelluloses,by cell wall bound peroxidases. Hence, syringyl lignin is composed mainly of $\beta$-O-4 ether linkage and that the hemicelluloses are easily connected to $\alpha$-position of lignin via quinonemethide intermediates to give LCC.

**Degradation mechanism of lignin by steam explosion. III. Degradation of non phenolic $\beta$-O-4 lignin substructure model compound by steam treatment,** M. KARINA, M. TANAHASHI and T. HIGUCHI: Mokuzai Gakkaishi, **36**, 466-473, (1990)

The degradation machanism of lignin by steam treatment was studied using guaiacylglycerol-$\beta$-guaiacyl ether (I), 3,4-dimethoxyphenylglycerol--guaiacyl ether (II) and 3-methoxy-4-benzyloxyphenylglycerol-$\beta$-guaiacyl ether (III) as lignin substructure model compounds. These model compounds were subjected to steam treatment (28 kg/cm$^2$, 230°C for 4 min) with linter cellulose: By the steam treat ment, (II) and (III) were found to be cleaved homolytically at the C-4 position and converted to (I). Coniferyl alcohol was the major product from (I), and dimers, *d,l-* and *d,l-epi*-pinoresinols and dehydrodiconiferyl alcohol were obtained. In addition, vanillin, guaiacol, coumaran, *cis-* and *trans*-stilbenes, vanillyl alcohol and coniferyl aldehyde were detected. Other products derived from (II) and (III) were identical with those from (I). In addition, from (II) and (III), 3,4-dimethoxycin-

namyl alcohol and benzylconiferyl alcohol were detected respectively. However, under the condition of steam treatment used, $\beta$-aryl ether bond in non phenolic lignin substructure model compound was cleaved much more slowly than that of phenolic compound. The results suggested that the cleavage of lignin by steam treatment was homolytic cleavage of its aryl ether bond with the formation of coniferyl alcohol radical which is converted to coniferyl alcohol and its dimers.

**Structure and properties of chemically treated wood,** M NORIMOTO: Mokuzai Kogyo (Wood Industry), **44**, 513-519 (1989)

A review on the relationship between structure and properties of chemically treated wood.

**Wood bending using microwave heating,** M. NORIMOTO and J. GRIL: J. Microwave Power and Electromagnetic Energy, **24**, 203-212 (1989)

This article presents a new technique of wood bending where microwave irradiation is used to heat and soften wet wood specimens. Compared to the traditional steaming procedure, this procedure offers many advantages: (i) as the heating occurs inside the specimen, complete softening is obtained very quickly; (ii) temperature can be easily controlled in order to obtain the best processing conditions; (iii) the benefit will be especially big in the case of large specimens whose pretreatment may take hours with steaming; (iv) in general, the applicability of wood bending is enlarged, i.e. new wood species and specimens with lower quality can endure larger deformations with a reduced loss. In the case where dractic strain levels are required, the forming and setting operations should be done inside the microwave oven, in order to take advantage of the additional "mechano-sorptive" flexibility appearing when wood dries under load.

**Dielectric relaxation of water absorbed on wood,** G. ZHAO, M. NORIMOTO T. YAMADA and T. MOROOKA: Mokuzai Gakkaishi, **36**, 257-263 (1990) (in Japanese)

No dielectric relaxation was observed for completely dried trityl cellulose. However, a clear dieletric relaxation occurred when it contained a small amount of water. This fact shows that the adsorbed water itself can be responsible for the relaxation. On the basis of this result, the value of the dielectric loss due to the adsorbed water separated from that of Sitka spruce (*Picea sitchensis* Carr.) wood containing water, and the enthalphy, entropy, and free energy of activation for the relaxation due to the adsorbed water were calculated as a function of the moisture content of the wood. These results showed that the relaxation of the adsorbed water and ice strikingly resembled each other. It was supposed that the relaxation resulted from the reorientation of water molecules accompanied by the cutting of

the hydrogen bonds, and the changes of the enthalpy and entropy of activation for the relaxation with moisture content were associated closely with the number of hydrogen bonds broken and number of water molecules concerned with the reorientation.

**Humidity conditions caused by wood,** M. NORIMOTO, T. OHGAMA and T. YAMADA: Mokuzai Gakkaishi, **36**, 341-346 (1990) (in Japasese)

The relave humidity (H(T)) as a function of temperature (T) in a box (20 cm × 20 cm × 30 cm) constructed of steel plates and lined with an interior-wall material was measured when its ambient temperature was changed from 20°C to 30°C. The logarithm of H(T) was represented approximately by a linear equation of T, and the degree of humidity conditions was evaluated by the slope (B) of the equation. Sitka spruce wood (*Picea sitchensis* Carr.), wall paper (polyvinyl chloride), and wood overlaid with wall paper were used as wall materials. The relationship between B and the ratio of the area (A) occupied by the wall material to the volume (V) of the box (A/V) was determined at various increasing temperature rates ($\Delta T/\Delta t$). The value of B for all of the wall materials depended on both the parameters, A/V and $\Delta T/\Delta t$. The values of A/V at the same value of B were compared between the wall materials. Also, both the temperature and the relative humidities in a house lined with wood or wood overlaid with wall paper were observed, and the results were compared to those obtained in the steel box. It was shown that the relative humidity changes in the house could be estimated from the experiments with the steel box.

**Some physical properties of cellulose derivatives prepared by homogeneoes periodate oxidation,** T. MOROOKA, M. NORIMOTO and T. YAMADA: Cellulose and Chemistry-Proceedings of the Tenth Cellulose Conf., 1103-1118, John Wiley and Sons Inc, New York (1989)

Homogeneous periodate oxidation of cellulose was attempted by using methylol cellulose. The dissolution of methylol cellulose into aqueous periodate solution was followed by the gradual decomposition of methylol groups at random sites along the mathylol cellulose chain. The recovery of glycol hydroxyl groups at the $C_2$ and $C_3$ positions on the glucopyranose ring during the above decomposition process caused uniform cleavage of $C_2$-$C_3$ bonds by the periodate ion. The oxidation level reached nearly 100% in ten hours. The reduced product of the resulting dialdehyde cellulose, ie., dialcohol cellulose, resulted in mechanical properties quite different from those of convertional dialcohol cellulose. Examination of the thermal deformation and tensile properties revealed that no notable cellulose degradation occurred during the reaction. Our dialcohol cellulose resulted in a clear and transpa-

rent film with a flexible nature.

**Production of oriented board with an electrostatic field III. Semi-strand board having better orientation toward both surfaces,** H. SASAKI, S. KAWAI, O. R. PULIDO and N. PENGPRECHA: Mokuzai Gakkaishi, **35**, 725–730 (1989)

An oriented mat-forming method for small-sized particles (semi-strands) utilizing a high voltage electrostatic field is proposed. The special features of the method are: 1) Electrodes are located only on the reverse side of the forming belt so that the unstable movement of particles is eliminated, 2) A special mat having better orientation towards the bottom surface is formed, and the top (less-oriented portion) in shaved-off to obtain even thickness, and 3) Two mats are mated together resulting in a double mat with better orientation towards the surfaces. Oriented boards of 6 mm thickness and density of 0.7 g/cm$^3$ were produced by this method from lauan (*Shorea* spp.) and Japanese red pine (*Pinus densiflora* S. and Z.) strands, and board propertias were tested. Modulus of elasticity, modulus of rupture and linear expansion in the oriented direction were 2.3–2.9, 1.7–2.0, and 1/5–1/3 times those in the cross direction, respectively. These values corresponded to 1.6–1.7, 1.2–1.6, and 1/3–1/2 times those of random boards, respectively. Bending-creep deflection in the oriented direction was as small as that ob plywood. From these results, it was concluded that the proposed method-should be effective in producing oriented semi-strand boards with small thicknesses. Finally, a production system applying the above method is proposed.

**Oriented mat former with high voltage system,** H. SASAKI, S. KAWAI H. WATANABE, O.R. PULIDO and Y. YOSHIDA: Mokuzai Kogyo (Wood Industry), **45**, 119–124 (1990) (in Japanese with English summary)

A test run of a pilot plant scale oriented mat former designed for semi-strand particles was conducted. Its special characteristics are as follows: A particle mat which have high degree of orientation towards the bottom is formed due to the arched electrostatic lines of force formed at the upper surface of the forming belt by electrodes arranged at its underside. The less-oriented top portion of the mat is shaved off to make an even mat with a desired thickness, then turned over and piled on top of another mat formed in the same way, resulting in a new mat with an increasing degree of orientation from its center towards both the surfaces.

Boards produced from this test plant have extremely even density. However, the anisotropicity of MOE and MOR were comparatively lower than those of oriented boards produced in a laboratory-scale former using the same principle. With some improvements at the electrode and mat turn-and-pile sections, this system can

be used for the production of thin boards as substitude for plywood.

**Present state and the future with development of wood new-composites,** H. SASAKI: Mokkou-kikai (Wood Working Machinery) No. 148, 9-12 (1990) (in Japanese)

The conclusions in this paper are as follows:

Wood-Based Panels and Lumbur-Like materials will have smaller wood elements in the future. These new wood-composites can be produced automatically, achieved higher yield and small variation in properties. Improvement of stability of these materials will need chemical treatment of wood elements. However steam treatment is also important method of dimensional stability of the wood-cmposite.

**Wood composites,** H. SASAKI: Special Rept. on Process and Technology, Japan Woodworking Association, 32-50 (1990)

Change in concept or purpose on production of New Wood Products was analysed, and the author concluded that the wood-elements for these new wood-composites will necessarily be smaller than those in the present time. Chemical treatment and treatments, with high pressure watervapor will become more important than the other chemical treatments.

**Fire retardants for wood and wood-based materials. I,** S. ISHIHARA: Mokuzai Kogyo (Wood Industry), **45**, 2-6 (1990) (in Japanese)

**Fire retardants for wood and wood-based materials. II,** S. ISHIHARA: Mokuzai Kogyo (Wood Industry), **45**, 203-209 (1990) (in Japanese)

**Carbon composites from wood charcoal and graphite as an electromagnetic shield and fire resistive material,** S. ISHIHARA: Nenryo Kyokai-shi (J. of the Fuel Soc. of Japan), **68**, 848-489 (1989) (in Japanese)

**Wood composites,** S. ISHIHARA: Mokuzai Kogyo (Wood Industry), **44**, 665-670 (1989) (in Japanese)

**Combustion of Wood and its control.** S. ISHIHARA, Mokuzai Gakkaishi, **35**, 775-785 (1989) (in Japanese)

**Boron and its compounds,** S. ISHIHARA: Mokuzai Hozon (Wood preservation), **15**, 248-260 (1989) (in Japanese)

**Flammability and 'physical properties of carbon-based overlaid composite boards,** S. ISHIHARA, S. KAWAI, Y. YOSHIDA and A. TAKAMATSU: Zairyou (J. the

Society of Materials Science, Japan), **38**, 1085-1091 (1989) (in Japanise with English summary)

Various kinds of carbon were used as the surface materials in the manufacture of fire resistive composite boards. The fire resistive boards were tested by an oxygen index method in accordance with the Japanese Industrial Standards (JIS) K 7201, and by a burn-through method. Flammability of the carbon-based boards decreased with an increase in board density. Fire endurance of the carbon-based boards was found to increase in the order of natural amorphous graphite, synthetic graphite, charcoals from bark, sawdust and rice hulls, anh natural crystalline graphite. Electric resistivity of these boards increased in the order of natural crystalline graphite, synthetic graphite, natural amorphous graphite, rice hull charcoal, bark charcoal, and sawdust charcoal. Bending strength of the carbon-based board -ds increased with an increase in density of boards. Reinforcing with glass whiskers did not improve the bending strength of natural crystalline graphite-surfaced composite board.

**New development of composite wood**, S. KAWAI: Text of a lacture sponsored by Japan Wood Preservation Association, Tokyo, 3-18 (1989) (in Japanese)

The trend of the recent development of composite wood is discussed and the features of newly developed composite wood were summarized. The fine resistance of carbon graphite overlaid particleboard, and water- and decay resistance of acetylated particleboard was introduced.

**Durability of wood-based composition boards**, S. KAWAI: Mokuzai no kagaku to riyou gijutsu (Wood Science and Technology) ed. Japan Wood Res. Soc., **1**, 59-70 (1989) (in Japanese)

Durability of various wood-based composition boards against outdoor exposure and accelerated aging tests was reviewed and the test results were compared with each other. Biodegradation and the mechanical degradation of the boards was also discussed.

**Low-density oriented-particleboard made from *Albizzia falcata***, S. KAWAI, R.A. RAZALI, O R. PULIDO and H. SASAKI, Mokuzai Gakkaishi, **36**, 579-583 (1990)

Low-density oriented-particleboards were produced from albizzia (*Albizzia falcata* Backer) using an electrostatic orienter. Mechanical properties and dimensional stability of the boards in the density range of 0.3-0.6 g/cm$^3$ were determined. The results obtained were as follows: 1) The modulus of rupture in bending (*MOR*) and the modulus of elasticity (*MOE*) of oriented particleboards satisfied the requirements for Japanese Industrial Standard 240-100 type at the density level of 0.45

g/cm$^3$. Anisotropy of boards, that is, alignment ratios achieved with the electrostatic orienter ($MOR_{/\!/}/MOR_{\perp}$=1.5 and $MOE_{/\!/}/MOE_{\perp}$=2.0), were relatively small. 2) Internal bond strength (IB) of particleboards from albizzia satisfied the minimum requirements for structural panels even at a low density level of 0.3 g/cm$^3$. However, improvement on its poor dimensional stability in the thickness direction is necessary.

**Recent research and development of composite wood in North America and North Europe**, S. KAWAI: Mokuzai Kogyou (Wood Industry), **45**, 132-136 (1990) (in Japanese)

Recent research and development of wood-based panels in North America was reviewed. The development of lumber-like materials such as LVL (Laminated veneer lumber), Parallam (Parallel Strand lumber), and OSL (Oriented strand lumber) was also described.

**Recent research and development of processing technology of composite wood in North America and North Europe**, S. KAWAI: Gohan Report (Plywood Report), No. 15, 17-37 (1990) (in Japanese)

New processing technology for producing composite wood in North America and North Europe was introduced; those were preparation process of particles and fibers, steam-injection pressing, continuous pressing, and recent developmant in the field of mineral bonded particleboards.

**Influence of repeated shearing load on the rigidity reduction of molded particleboard wall panels**, S. TAKINO, H. SASAKI, M. MASUDA: Mokuzai Gakkaishi, **36**, 347-353 (1990) (in Japanese with English summary)

For studying the horizontal shear-rigidity properties of molded particleboard wall panels, programmed cycle-loadings were applied to wall panels under dry conditions and also under wet conditions. The programmed cycle-loadings corresponded to accumulative wind loads and seismic loads for the durability period (30 years). Ramp-loading type shear (racking) tests were made after the programmed cycle-loadings (repeated shearing loads). The results obtained were as follows: 1) After the programmed cycle-loadings, the shear rigidity of the wall panels decreased a little and there was little loosening of the bolts. 2) After water-spraying, consequent swelling and expansion of the panels caused tightening of the bolt joints. Then shear rigidity of the complex wall increased, that is, shearing strain decreased. 3) After water-spraying for one more week and the following drying under room conditions for five days, the shear rigidity of the complex wall decreased because of loosening of the bolt joints. 4) Shear rigidity and strength of the molded

particleboard wall panels were large enough to bear the repetitive wind loads and the saismic loads for the durability period, but loosening of the bolt joints by repetitive swelling and shrinkage, that is, compression shrinkage, was thought to be a dominant factor in decreasing the shear rigidity of the wall.

**Production of oriented particleboard II, Aligning methods and board propertias**, Y. YOSHIDA. O R. PULIDO, S. KAWAI and H. SASAKI: Mokuzai Gakkaishi, **35**, 718-724 (1989) (in Japanese with English summary)

Oriented particleboards were manufactured from semi-strand type lauan (*Shora* spp.) particles. In the previous paper, it was suggested that the properties of thin particleboards were improved when an electrostatic method with the electrodes set on the reverse side of the forming conveyor-belt was used for orientation. This report compares the properties of thick particleboards manufactured by two methods of orientation: namely, machanical and electrostatic. The results are summarized as follows:

1) The electrostatically-oriented particleboard (E board) had almost the same modulus of elasticity (MOE) in the oriented direction as that of the machanically-oriented particleboard (M board), and was 1.4 times larger than that of random particleboard (R board). This suggests that this electrostatical-orientation system has more advantage than the mechanical-orientation system for practical application in oriented-mat formation.

2) The internal bond strength of E boards manufactured with larger voltages is greater than those of R boards or M boards.

3) No effects of the orientation method and the degree of orientation were observed on thickness swelling when the particleboards were immersed in water. An orthological anisotropy of linear expansion was observed for both E boards and M boards when they were immersed in water. E board is more dimensionally stable in the cross direction than M board because of the multi layer construction of the former.

**Aligning torque generated on wood particles by an electrostatic field III. Generation mechanism of aligning torque**, Y. YOSHIDA, O R. PULIDO, S. KAWAI and H. SASAKI: Mokuzai Gakkaishi, **36**, 523-530 (1990) (in Japanese with English summary)

Aligning torque generated on the particles made of wood, metal and plastic by electrosatic field was measured. The results are summarized as follows:

1) Particles were set in the space where an electrosatic field was formed uniformly at a field-intensity level of 1-4 kV/cm. At this point, the effect of the insulation of the particles was observed on the aligning torque. When there was no insulation

breakdown, the aligning torque increased or decreased depending on the material of the particles within the range between the lower-limit value (=0) and the upper -limit value which are a function of particle size and field intensity. With insulation breakdown, the lower aligning torque was generated with greater conductivit of the particles. 2) The upper limit value of the aligning torque observed for metallic particles without an insulation breakdown, but the aligning torque decreased with insulation breakdown. 3) The lower-limit value of the aligning torque was observed for plastic particles. When the surfaces of the plastic particles were treated with an ionic surface-active agent, the aligning torque increased remarkably, and its value nearly reached the upper-limit. 4) The aligning torque generated for wood particles increased with increases of moisture content (MC), which is in the range of absorbed water, and its value reached the upper limit. With insulation breakdown, the aligning torque generated for wood particles was greater than that for metallic particles because the conductively of wood at a high level of MC is much less than that of metal. 5) It is suggested that aligning torque was generated because of Coulomb's force acting on electricity generated by a moving electric charge career (metal-free electron; wood-absorbed water ion, etc) on particle surfaces.

**Production of oriented board with an electrostatic field IV. Improved manufacturing method for particleboards with better orientation**, Y. YOSHIDA, O R. PULIDO, S. KAWAI and H. SASAKI: Mokuzai Gakkaishi, **36**, 305-313 (1990) (in Japanese with English summary)

Featured is the original electrostatic orienter with the electrodes on the reverse side of the forming conveyor belt as reported in the previous paper, improved to attain better orientation of the particle mat. Oriented particleboards from lauan (*Shorea* spp.) semi-strand particles were manufactured using this improved orienter. The results are summarized as follows:

An electrode cover-plate of sugi (*Cryptomeria japonica*) veneer was inserted for insulation between the forming conveyor belt and the electrodes on the reverse side of the forming conveyor belt. Another electrode was placed on the upper surface of the sugi veneer. The aligning torque generated on particles was intensified more with this improved orienter than with the original orienter so that better orientation of the particle-mat was observed. Oriented boards were manufactured by the process of hot-pressing the double mat formed by matting together two oriented mats. The modulus of elasticity and the modulus of rupture, of the oriented boards of 0.4 g/cm$^3$ density, in the oriented direction were 4.8 and 3.2 times those in the cross direction, respectively. These values corresponded to 2.0 and 1.7 times those of

random boards, respectively. Thus, this orienter succeeded in improving the bending properties of the boards with better orientation than those of original orienter.

**Production of particleboard with a steam-injection press III. Effects of injection time and timing on board propreties**, T. HATA, B. SUBIYANTO, S. KAWAI and H. SASAKI: Mokuzai Gakkaishi, **35**, 1080-1086 (1989) (in Japanese with English summary)

The effects of injection time (0-30s) and injection timing of high-pressure steam from hot platens on the physical properties of particlebords with a density range of 0.4-0.6 g/cm$^3$ using an isocyanate compound adhesive were investigated as the first step to determine the optimum conditions for steam-injection pressing. The results are summarized as follows;

1) In conventional hot platen pressing, the density distribution through the board thickness had a "U" shaped distribution pattern with the densest layers near both surfaces and a less dense core, whereas in steam-injection pressing, the distribution was rather uniform. This difference was clearer in boards having a density of 0.6 g/cm$^3$ than in those of a 0.4 g/cm$^3$ air-dry density. 2) The flexure properties of the greater density boards made with steam-injection pressing had values a little smaller than those made with conventional hot-platen pressing. The internal-bond strengths of the boards, however, increased remarkably with steam injection pressing. The withdrawal-resistances of screws from the edges of the boards and their dimensional stability under wet conditions also tended to increase because of the uniform distribution of density in the boards described above. 3) The board properties were almost independent of the steam-injection time. Enough energy to produce 20 mm thick boards could be supplied with a 3 to 10-second injection followed by about 3.5 minutes of hot presseng. 4) The bending properties tended to increase with delay of the initiation of the steam injection in most dense particleboards. This means that sufficient contact between particles before steam injection is best. 5) In spite of the above results, initiation of the steam injection at the compaction ratio of 1.0 to 1.3 would be rational for shortening the total press time because a longer pressing time and a greater pressure are needed to compress the mats to a target density in the production of boards of greater densities.

**Production of particleboard with a steam-injection press IV. shortening the press cycle with steam injection**, T. HATA, B. SUBIYANTO, S. KAWAI and H. SASAKI: Mokuzai Gakkaishi, **35**, 1087-1091 (1989) (in Japanise with English summary)

To find the necessary minimum press time required for steam-injection pres-

sing, particleboards with a thickness of 20 mm using an isocyanate-compound adhesive was produced, and the effects of pressing time on their physical properties were investigated. The results are summarized as follows:

1) Steam-injection pressing makes it possible to produce 20 mm thick particleboards with a press time of 45s for 0.4 g/cm$^3$ boards and 60s for 0.6 g/cm$^3$ boards. This corresponds to only 1/5~1/6 of the press time of conventional hot-platen pressing. 2) The steam-injected boards had bending properties that had slightly less values than those of conventional platen-pressed boards. They had, however, greater internal-bond strengths and screw withdrawal-resistances at edges of the boards.

**Production of particleboard with steam-injection, Part 1. Temperature behaviour in particle mat during hotpressing and steam-injection pressing,** T. HATA, B. SUBIYANTO, S. KAWAI and H. SASAAKI: Wood Science and Technology, **23**, 361-369 (1989)

The temperature behavior of the particle mat during hotpressing and steam-injection pressing was investigated under various conditions: in the case of hotpressing, it required about 3 and 11 minutes to increase the temperature to 100°C at the middle layer of a mat with a thickness of 20 and 40 mm, respectively. With an increase of moisture content, the time necessary for the middle layer to reach 100°C tended to shorten, whereas the time to maintain a constant temperature (about 100°C) was prolonged. The temperature in the middle layer of a mat with a higher moisture content in the face layers increased at a rate four times that of a mat with a uniform distribution of moisture content. In the case of steam-injection pressing, the temperature in the middle layer of mats with a thickness of 20 and 40 mm increased beyond 100°C at the moment of steam-injection, and maintained a constant level during steam-injection. After stopping steam-injection, the temperature decreased to about 100°C, and then started to rise gradually again. With the steam injection process, the moisture content of the mat did not increase as much as usual, and the rates of temperature increase in the middle layers of mats with different thickness, moisture content and density were similar. After the steam-injection had been stopped, the temperature of dry mats kept rising, whereas that of mats with a moisture content of 11% decreased to 100°C and then increased gradually. When the steam pressure for injection was higher the vapor pressure or temperature at the middle layer increased to a higher level.

**Production of particleboard with steam-injection, Part 2. Computer simulation of temperature behaviour in particle mat during hotpressing and sdeam-injection pressing,** T. HATA, S. KAWAI and H. SASAKI: Wood Science and Technology, **24**, 65-78 (1990)

The temperature distribution in particle mats during hotpressing and steam-injection pressing was numerically analyzed with the finite element method under various conditions. Calculated results agreed comparatively well with the observed results (Hata) in either method of pressings, which proved that the analytical theory was useful to predict the temperature behavior of particle mats during hotpres-sing and steam-injection pressing. In hotpressing, the core temperature increase was propotional to the temperature of the hotplatens and was inversely proportional to the square of the mat thickness. The effects of the mat density and of the density distribution along the mat thickness on the core temperature curves were negligibly small. In steam-injection pressing, with increases of mat thickness the injection time necessary for raising core temperature up to 100°C increased. For the core temperature of a 500-mm-thick mat, it will take about 180 seconds to reach 100°C. Core temperature immediately after steam injection increased with an increase of steam pressure of steam pressure for both 20-and 40-mm-thick mats. While thinner mat results in higher maximum temperature achieved by steam injection, the increase of mat core temperature by steam-injection is not significantly influenced by mat density.

**Oriented medium-density fiberboard produced with an electrostatic field II. Method of producing yarns from wood fibers and its application in oriented medium-density fiberboard production**, O R. PULIDO, S. KAWAI, Y. YOSHIDA and H. SASAKI: Mokuzai Gakkaishi, **36**, 29-35 (1990)

A new method of yarning wood fibers was developed for oriented medium-density fiberboard (OMDF) production. This method is based on the principle of passing a constant quantity of fiber mat between two yarning surfaces with a sufficient of friction, running at different speeds relative to each other. Softwood fibers were yarned with a rubber roller and belt yarning system.

In yarning, the length of individual fibers, the angle between the electrostatic pre-orientation of the fiber mat and the axis of yarning roller, and the relative speed between the yarning surfaces affect the configuration of resulting yarns. In aligning fibers and yarns by the electrostatic method, the average aligning angle was found to be a linear function of the length of the fibers and yarns, and better alignment could be obtained in yarns than in fibers. OMDF manufactured from yarns using this method had orientation indices (property ratios in oriented/cross directions) of 1.9 and 1.6 for modulus of elasticity (MOE) and modulus of rupture (MOR), respectively. MOE and MOR in the oriented direction are greater than of directly oriented or of random MDF made from unyarned fibers.

**Studies on the bumboo fiberboard**, T.Y. CHEN, Y. SAWADA, S. KAWAI, M.

TANAHASHI and H. SASAKI: Taiwan Wood Industry, **8**(4), 11-18 (1989) (Chinese with English summary)

For this study, the density of bamboo fibercboard was took example by 0.7 g/cm$^3$ in explanation. The fiberboard made from Mousou and Madake bamboo showed that the difference of the properties was insignificant. The fiberboard made from Mousou outer layer showed higher MOR (350 kgf/cm$^2$) than that from bamboo joints (200 kgf/cm$^2$). After wet treatment (2 hrs boiling and 1 hr soaking in room temperature cool water) the strength retained about 26-43% only. The mat forming by orientation method with static electricity could improve on the strength ($MOR_{//}/MOR_{\perp}=1.33$:$MOE_{//}/MOE_{\perp}=1.52$). The fiberboard made from Mousou middle layer showed the highest internal bond (35 kgf/cm$^2$). The bamboo fiberboard soaked in water for 24 hrs and 30 days showed the thickness swelling was not significant (6.1-9.5%), but the wet treatment let the thickness swelling increased obviously.

**Improving bonding properties of bamboo**, Z. CHANG, P. YANG, Y. SAWADA, S. KAWAI and H. SASAKI: Mokuzai Kogyo (Wood Industry), **45**, 16-20 (1990) (in Japanese)

Bonding properties of outer surfaces, sliced surfaces and inner surfaces of two bamboo species (Madake: Phyllostachys bambusoides SIEB. et ZUCC and Mousochiku: Phyllostachys heterocycla Pubessens MUROI) were tested with phenol resin (PF: Mitui-Toatsu Kagaku Corp. PL281) and isocyanate compound (IC: Gun-Ei Kagaku Corp. UL-4811) adhesives.

Surfaces of these specimens were treated by sand-blasting or dipping in sodyum carbonate solution. The results are as follows.

1) Sliced surfaces had always good bond with both adhesives, while outer or inner surfaces had only weak bondability with isocyanate.

2) Sand blasting was more useful in improving bondability of the outer or inner surfaces than chemical treatment.

**Utilization of laminated-veneer-lumber from Sabah plantation thinnings as beam flages I. Increasing confidence limits in properties by processing into laminated-veneer-lumber**, Q. WANG, T. HAYASHI, H. SASAKI and Y. NAGAYA: Mokuzai Gakkaishi, **36**, 624-631 (1990) (in Japanese with English summary)

The mechanical properties of laminated-veneer-lumber (LVL, 2.5 mm veneer, 9-ply) manufactured separately from four fast growing species [*Acacia mangium* Willd. (AM), *Eucalyptus deglupta* Bl. (ED), *Gmelina arborea* Linn. (GA), and *Albizia falcata* Back. (AF)] of Sabah (Malaysia) forest plantation thinnings are discussed.

1) The average value of modulus of elasticity of LVL of each species increased 16% compared to those of dimension lumber because of the effect of compac-

tion, and the deviations decreased by more than 50%.

2) Although there were no increases in the average moduli of rupture (*MOR*) of LVL of all species compared to those of dimension lumber, the standard deviation was significantly small, and the 5% exclusion limit was estimated to increase by from 16% (ED) to 73% (AF) more than those of dimension lumber. Therefore, the strength performance and safety in structural use are greatly improved by processing wood into LVL.

3) Simulation models based on the central limit theorem, as well as the fract -ture mechanics theory, could estimate the distribution function of specific gravity, modulus of elasticity (*MOE*), and *MOR* of LVL from those of solid wood.

**Evaluation of termiticides in field trials**, M. TAKAHASHI, Y. IMAMURA, K. TSUNODA, A. ADACHI and K. NISHIMOTO: Int. Res. Group on Wood Preserv. Document No. IRG/WP/3633 (1990)

Termiticide-treated posts and stakes have been tested at the field test site in Kagoshima, Southern Kyushu, Japan. Various commercial and alternative termiticides have been evaluated annually as TAI (termite attack index), calculated by the equation: $TAI = R \times P$, where R is the mean of attack rating of 0 (sound), 10 (sign of tasting), 30 (slight attack), 50 (moderate attack), 100 (severe attack), and P is the ratio of attacked posts (stakes) to total posts (stakes) tested, expressed as 0.0-1.0.

CCA-impregnated Japanese cedar (*Cryptomeria japonica*) posts have well performed keeping 0 TAI over nine years. AAC-treated pine (*Pinus radiata*) stakes with 9.3 kg/m$^3$ DDAC (didecyldimethyl ammonium chloride) or 9.4 kg/m$^3$ BTAC (methylalkylbenzyltrimethyl ammonium chloride) have been free from decay, but they yielded 34 or 42 TAI after eight years. Improvement of termite resistance was revealed by adition of cupric chloride or cuprammonium chloride. Brushing treatment of pine (*P. densiflore*) stakes, with 200 g/m$^2$ chlordane (2.0%), chlorpyrifos (150%) or tetrachlorvinfos (1.0%) solutions, did not provide the perfect control for five years, yielding 30, 42 and 48 TAI, respectively.

**Recent wood-preserving techniques for prevention of biodeterioration**, M. TAKAHASHI: Mokuzai Kogyo (Wood Industry), **45**, 150-156 (1990) (in Japanese)

Recent wood-preserving techniques for control of biodeterioration is briefly described together with the historical survey on wood preservatives. The related problems on durability of wooden housing members are also discussed with their different conditions in use.

**Outline of the 21st IRG Conference in New Zealand—Japan Conference, it**

**is only a year away**—, M. TAKAHASHI: Mokuzai Hozon (Wood Preservation), **26**, 206-211 (1990) (in Japanese)

Outline of the 21st IRG (International Research Group on Wood Preservation) Conference at Rotorua, New Zealand is described with scientific reports and managements, from a standpoint of organizer for the next Japan Conference.

**Boilogical resistance of phenol-resin treated wood.** M. TAKAHASHI and Y. IMAMURA: The Int. Res. Group on Wood Preserv. Document No. IRG/WP/3602 (1990)

Biological resistance of PF (phenol formaldehyde resin)-treated wood has been tested in relation to the resin properties, wood species and biological factors. When tested using water-soluble PF (mol. wt. 170), ca. 10% RI (resin impregnation) was enough to suppress the decay of Japanese cedar (*Cryptomeria japonica*) and western hemlock (*Tsuga heterophylla*) blocks exposed to *Tyromyces palustris* (brown-rot type) and *Coriolus versicolor* (white-rot type). For a decay suppression of Japanese beech (*Fagus crenata*) by treating with the same PF, ca. 20% RI was required for both cases of exposure. When using ethanol-soluble PF (mol. wt. 300), the lesser effect on decay suppression was revealed for most of wood-fungus combinations, suggesting a possible better penetration of lower molecular resin into the wood cell walls.

PF treatment of wood also affected the termite *Coptoterms formosanus*, causing the severe depletion of feeding activity and the higher mortality at 5-15 (%) RI. Of the three species of symbiotic protozoa, the most cellulolytic *Pseudotrichonympha grasii* diminished first shortly after feeding.

**Property enhancement of *Albizia falcataria* particleboards made from acetylated particles,** Y. IMAMURA, M. TAKAHASHI, B. SUBIYANTO and S. YUSUF: Proceeding of the 2nd Pacific Regional Wood Anatomy Conference (1989)

Mechanical and physical propertias, and biological resistance were evaluated on low-density acetylated particleboards from Indonesian fast-growing and perishable timber, *Albizia falcataria* (L.) Fosb. Acetylated particles with 5, 12 and 20% weight gains (WGs) were pressed into boards using phenol formaldehyde (PF) and isocyanate (IC) resins. The values of mechanical properties of IC-bonded boards decreased with increasing acetyl WG whereas no serious effects were observed with PF-bonded boards. After wet treatment, acetylated boards with a 20% WG retained 80% of bending strength in a dry condition reflecting the increased water-resistance of highly acetylated particleboards. The dimensional stability of both IC-and PF-bonded boards improved dramatically with increasing acetyl WG. Results obtained from accelerated laboratory tests on biodegradation suggested that higher acetylation works well to enhance decay resistance of particleboards from perishable *A. falcata*.

SEM observations showed that the proportion of glue line failure rapidly increased after exposure to fungi decay in untreated control boards while acetylation reduced the attacks int the glue lines as well as reducing erosion of the wood particles.

**Anatomical characterization of vascular bundles in oil palm trunks,** M.Z. JUSOH and Y. IMAMUAA: Proceedings of the 2nd Pacific Regional Wood Anatomy Conference (1989)

Observations by scanning electron microscopy and optical microscopy were employed for characterization of vascular bundles in trunks of the oil palm (*Elaeis guineensis*). The difference in distribution of vascular bundles between the peripheral zone and the inner zone of the trunk was quite prominent, and the amount of fibers of the well-developed multilayered wall and the degree of their lignification depended upon a given age of the organ and its portion in the trunk. Silica-containing cells were visualized being associated with the external surfaces of isolated vascular bundles.

**High-durable paticleboards through chemical modification,** Y. IMAMURA: Mokuzai Kogyo (Wood Industry), **44**, 634-636 (1989) (in Japanese)

A brief report of the current research on chemically modified particleboards was presented along with results found on biological tests of acetylated boards.

**Wood-inorganic compound complex—New fire-retardative materials with high performance,** Y. IMAMURA: Zairyou (J. Soc. Mat. Sci., Japan), **38**, 1224-1225 (1989) (in Japanese)

New method to produce fire-retardative wood-based materials through complex with inorganic compounds was explained. Improvement of fire resistance was attained by the double diffusion treatment of barium chloride and ammonium phosphate and *in situ* reaction in wood. SEM observations demonstrated the formation of water-insoluble deposits at the cell lumina and in the cell walls of the treated wood.

**Using acoustic emission monitoring to detect termite activity in wood,** Y. FUJII, M. NOGUCHI, Y. IMAMURA and M. TOKORO: Forest Prod. J., **40**, 34-36 (1990)

Acoustic emission (AE) of the "burst type" was detected from western hemlock specimens under termite attack, using a 150 kHz AE sensor at 70 dB gain and 0.1 V threshold. The AE event rate increased with increasing numbers of workers present, while no AE events were detected from the specimens with solders only. The source location of events revealed that the distribution of AE sources roughly

corresponded to the regions fed upon by termites and, furthermore, that many events arose near the forefront of gallaries. This study demonstrates the feasibility of using AE monitoring to detect termite activity, although further development is necessary.

**New technology to modify disadvantageous properties of wood,** Y. IMAMURA: Shin Juutaku (New Housing), **45**, 118-119 (1990) (in Japanese)

New principles to impart biological resistance and incombutibility to wood was presented. Notable improvement in resistance against fungal and termite attack through chemical modification or combination with bioactive polymers was briefly described. Production of wood-inorganic compound complex was also explained as fire-retardative wood-based materials.

**Dimensional stability, biological resistance, and mechanical properties of phenol-resin-treated particleboards,** Y. IMAMURA and H. KAJITA: The Int. Res. Group on Wood Preserv., Document No. IRG/WP/3622 (1990)

Particleboards were treated with a low molecular-weight phenol-resin and their enhanced properties were evaluated. Beside dipping of particles in aqeous solutions of the resin and spraying of the resin solutions before spray of the conventional phenol resin for adhesives, one step treatment by spraying of the mixture of impregnation and adhesive resins was also employed. After 2-hour boiling, the boards treated at 10% weight gain (WG) due to uptake of impregnated resin-solid retained 80% of their strength values in a dry condition. The internal bond strength increased with increasing WGs, and the boards of 20% WG showed twice of the value of untreated controls in the same level of board density. Treated particleboards resulted in a more dramatic reduction in the rate of swelling even though at low resin loadings. Results obtained from accelerated laboratory tests on biodegradation suggested that impregnated resin-solid works well to enhance decay and termite resistance of particleboards.

**Detection of termite attack in wood using AE monitoring,** Y. FUJII, M. OWADA, M. NOGUCHI, Y. IMAMURA and M. TOKORO: The Int. Res. on Wood Preserv., Document No. IRG/WP/2355 (1990)

An AE (acoustic emission) monitoring method for detecting termite activities in wood was applied to lumbers of 3 cm by 3 cm to 10 cm by 10 cm square, 1m long, and the propagation of AEs due to feeding activities of termites and the location of AE sources were discussed. Also discussed was the feasibility of the method for the posts in the field of subterranean termites. The results obtained from laboratory and field tests suggested that the their feedngg activities could be

detected even in the incipient stage by AE monitoring.

**Application of AE monitoring method to detection of termite activitias,** Y. IMAMURA and Y. FUJII: Termite (Shiroari), No. 81, 3-10 (1990) (in Japanise)

New method to detect termite activities using acoustic emission (AE) monitoring was described. Relationship between AE events and the degree of termite attack in wood, and the effect of puffing or knocking stimulation on the feeding activities were discussed. It was also shown that AE monitoring test was not only a reliable method to nondestructively detect the termite attack in wood, but was an effective means to get much information on the feeding behavior of wood-attacking insects.

**A report of travel to Peninsular Malaysia, Sabah and Sarawak,** Y. IMAMURA: Mokuzai Hozon (Wood Preservation), **16**, 23-33 (1990) (in Japanese)

Current trend of forest resources and the wood industry in Peninsular Malaysia, Sabah and Sarawak was reported along with author's study tour under the auspieces of Japanese Society for Promotion of Science. The cooperative research of Japanese Society for Promotion of Science. The cooperative research between Wood Research Institute and University of Pertanian Malaysia was also explained with the identified topics on efficient utilization of wood residues, plantation species and non-wood raw materials.

**Effect of soil burial on the termiticidal performance of pyrethroids,** T. YOSHIMURA, K. TSUNODA and K. NISHIMOTO: Mat. u. Org., **24**, 227-238 (1989)

Effect of weathering on the termiticidal performance of three synthetic stable pyrethroids was investigated by exposing wood blocks (sapwood of *Pinus densiflora* Sieb. et Zucc., brush treated with kerosene solutions of pyrethroids at a rate of $110\pm10\,g/m^2$) to unsterile soil burial for 3, 6 and 12-weeks at $26\pm2°C$ and $90\pm5\%$ R.H. The blocks were consecutively subjected to the attack of subterranean termites, *Coptotermes formosanus* Shiraki according to the Japanese standardized test method and chemical analyses were conducted by GLC to determine recovery rates after soil burial.

Permethrin, fenvalerate and fluvalinate performed well after 12 weeks' soil burial at 1.0% treatment. At 0.4% treatment, three pyrethroids maintained sufficient termiticidal effectiveness when soil burial was shorter than 6 weeks. When the period of soil burial was longer than 6 weeks at 0.2% treatment and 12 weeks at 0.4% treatment, weight losses of test blocks were over 3% which was the maximum limit for a good termiticide according to the qualitative requirement of the standardized method. These results suggested that the degree of effectiveness of the three

pyerethroids was almost equal to phoxim which was a widely used organophosphorous termiticide.

Recovery rates of the chemicals after soil burial ageing decreased with the period of soil burial. In addition, the higher treating strengths resulted in higher recovery rates. Such reduction in recovery rates agreed well with increased weight losses of the test blocks in the bioassay especially at lower concentrations.

**Effect of alkyl chain length on the fungicidal efficacy of benzalkonium chlorides,** K. TSUNODA: J. Antibact. Antifung. Agents, **18**, 185-189 (1990)

The effect of alkyl chain length on the fungicidal performance of benzalkonium chlorides was tested according to JIS A 9302.

In general, benzalkonium chorides were more effective against *Coriolus versicolor* (Linn. et Fr.) Quél. than against *Tyromyces palustris* (Berk. et Curt.) Murr. The order of alkyl chain lengths according to the fungicidal efficacy of their cholorides was $C_{14}=C_{16}=C_{18}>C_{10}=C_{12}>C_8$ against *C. versicolor* and $C_{18}>C_{10}=C_{16}>C_8=C_{12}=C_{14}$ against *T. palustris*. The most promising benzalkonium chloride ($C_{18}$) could control the attack of decay fungi at retention intervals of 2.1-3.2 kg/m$^2$.

On the basis of the present results, formulations which contain benzalkonium chlorides with alkyl chain lengths of $C_{16}$ and $C_{18}$ should be considered for use in timber preservation in the future.

**Role of wood-preserving techniques for developing novel woody materials,** K. TSUNODA: Mokuzai Kenkyu Shiryou (Wood Research and Technical Notes), No. 25, 22-31 (1989) (in Japanese)

Historical survey on Japanese wood preserving industry is briefly described and the derived problems are supplementarily discussed with new treating techniques and wood preservatives.

Based on the history of wood preservation in Japan, a few future research efforts are emphasized to develop highly durable woody materials.

**Japanese wood preserving industry,** K. TSUNODA: The Int. Res. Group on Wood Preserv. Document, No. IRG/WP/3596 (1990)

Although a great amount of wood is in use in Japan, a little attention has been paid to the significance and importance of wood preservation. The fact reflects that only less than 0.5% of the total wood consumption is treated with wood preservatives today in the country.

Over the 20 years before 1970, the annual volume of preservative-treated (pressure treatment) wood was relatively at a stable level of approximately 500,000 m$^3$. After the prominent peak of 709,000 m$^3$ in 1968, 500,000 to 600,000 m$^3$ of wood had

been annually treated until 1980. In the 1980's the pace of production of preservative-treated wood gradually declined, down to 400,000 $m^3$ in 1988.

As for commodities treated with wood preservatives, poles and sleepers have been remarkably decreasing, and wood foundation sills which newly appeared on the market in the late 1960's became a major item.

It is expected that new treated commodities will be accepted among Japanese poeple to stimulate the activity of wood preserving industry in Japan.

**Field evaluation of new anti-mold and anti-sapstain formulations**, K. TSUNODA: Mokuzai Hozon (Wood Preservation), **16**, 130–139 (1990) (in Japanese with English summary)

Newly designed testing method was proposed to evaluate the effectiveness of anti-mold and anti-sapstain formulations in the field.

Freshly sawn pine (*Pinus densiflora Sieb. et Zucc.*) boards were dipped in the solution of formulation for 30 seconds and subjected to outdoor exposure in piling with stickers on June 6, 1988. Thirty replicates were prepared for each treatment. Each test board was visually inspected after 1 and 2 weeks' and 1, 3, 6 and 12 months' exposure to evaluate the changes in persistence of effectiveness with time.

Among 5 formulations tested, a mixture of 2-(Thiocyanomethylthio) benzothiazole (TCMTB)+Methylene bis thiocyanate was the most effective at 1% of the formulation after 8 months' exposure. Two alternative candidates [TCMTB+3-Iodo-2-propynyl butyl carbamate, 4-Chlorophenyl-3-iodo-propargyl formal+2-(4-Thiazolyl) benzimidazole] were satisfactorily effective at 1% of the formulations in protecting timber for 3 months.

Conventional commercial agents which contained sodium trichlorophenate or trichlorophenol as a main active ingredient were less effective at an actual treating strength in controlling the growth of mold and sapstain fungi on wood.

The present testing method was proved to be useful for not only evaluating the efficacy of anti-sapstain formulations but also comparing the persistence of efficacy among the formulations tested.

**Isolation and identification of the trail pheromone of the subterranean termite *Reticulitermes speratus* (Kolbe). (Isoptera: Rhinotermitidae)**, M. TOKORO, M. TAKAHASHI and R. YAMAOKA: The Int. Res. Group on Wood Preserv. Document No. IRG/WP/1459 (1990)

The trial pheromone was successfully isolated from whole body extract of the termite *Reticulitermes speratus* (Kolbe) through various chromatographic reactions. Its trail-following activity was examined by bioassays. The primary structure of the pheromone was determined as normal chain dodecatrien-1-ol by capillary GC-

MS analysis. Moreover, by means of capillary GC-MS and capillary GC-FTIR analyses after acetylation, partial hydrogenation and ozonolysis, the complete structure of the trail pheromone was determined as *cis*-3, *cic*-6, *trans*-8-dodecatrien-1-ol.

As the amount of the trail pheromone per individual was considered extraordinarily small, it was hypothesized that the pheromone might be stored in the termite in the form of a precursor. The substance produced by hydrolysis of the inactive fractions obtained from silica gel column chromatography showed high trail-following activity, approximately 20 times as high as the original extract. Both of the chromatographic behavior and chemical properties of the hydrolyzed product corresponded to those of the native trail pheromone, which led to the conclusion that these two substances were identical. The fact suggested that the trail pheromone was stored in the form of precursor-like substance.

**Antifungal and termiticidal effectiveness of an organoiodine compound, 3-Iodo-2-propynyl butyl carbamate (IPBC)**, D H. LEE, K. TSUNODA and M. TAKAHASHI: J. Antibact. Antifung. Agents, **18**, 365-370 (1990) (in Japanese with English summary)

An organoiodine fungicide, 3-Iodo-2-propynyl butyl carbamate (IPBC) was proven to be satisfactorily effective against decay fungi in laboratory biological tests.

IPBC could fully protect timber from fungal attacks by superficial treatment at a concentration of 0.75% (w/w) which was much lower than those required for other currently used organoiodine compounds such as IF-1000 and EBIP, and an organotin compound TnBTO. IPBC effectiveness against *Serpula lacrymans* was lower than the other preservatives such as IF-1000 and TnBTO.

When applied to vacuum/soak impregnation of sapwood blocks, IPBC could perform well against *Tyromyces palustris* and *Coriolus versicolor* at retentions of 0.29–0.59 kg/m$^3$. Although IPBC itself did not have any apparent termiticidal efficacy, the addition of chlorpyrifos [1.0% (w/w)] resulted in desirable improvement. The mixed formulations were effective against all the test fungi at 0.25%.

The present laboratory evaluation definitely demonstrated that IPBC could be a potential alternative to conventional oil-borne wood preservatives, because it seemed to have promising preservative effectiveness in spite of low mammalian toxicity.

**Laboratory evaluation of azaconazole as a wood preservative**, D H. LEE, M. TAKAHASHI and K. TSUNODA: J. Antibact. Antifung. Agents, **18**, 169-177 (1990) (in Japanese with English summary)

The applicability of azaconazole, 1-{[2-(2,4-dichlorophenyl)-1,3-dioxolon-2-yl] methyl}-1H-1,2,4-triazole, in the control of wood-destorying fungi was investigated

by laboratory biological tests. According to Japan Wood Preserving Association Standard No. 1 for surface treatment (JWPA-test), azaconazole was effective in inhibiting the decay caused by *Tyromycespal ustris* and *Coriolus versicolor* at 0.25 and 0.75% (w/v), respectively. However, it was ineffective against *Serpula lacrymans*. The effectiveness of azaconazole against *S. lacrymans* was enhanced to some extent by addition of an organophosphoric termiticide chlorpyrifos, but it was almost nullified in the second decay test using same specimens after the first JWPA-test and/or subsequent 6-week exposure to unsterilized soil. Minimum Inhibitory Concentrations (MIC) of azaconazole for 42 species of wood-rotting and sap-staining fungi were determined using malt agar medium. Of the fungi used, 28 species including *T. palustris* and *C. versicolor* had low MIC under 100 ppm. *S. lacrymans* showed high MIC over 350 ppm. Detoxifying activity of azaconazole was estimated by its rate of concentration decrease in the culture filtrates after each time the culture was shaken. The activity of *S lacrymans* was higher than *T. palustris* but unexpectedly lower than *C. versicolor*. Higher resistance of *S lacrymans* against azaconazole might be more attributed to its high tolerance to this compound than to active detoxification. Azaconazole might be applicable to wood preservation in the above-ground situation without the risk of dry rot fungus *S. lacrymans*